

Enhanced recovery in intestinal surgery

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Abstract

Enhanced recovery after surgery (ERAS) programmes utilize a multimodal and multidisciplinary approach to surgical care. The aim of ERAS is to reduce the surgical stress response, to maintain physiological function and metabolic homeostasis and to expedite patients' recovery to their baseline status. Following its success in colorectal surgery, ERAS is increasingly adopted by other surgical specialities. A good ERAS programme involves integrated preoperative, intraoperative and postoperative evidence-based practice. Successful ERAS programmes translate to a standardized patient care pathway, improved clinical outcomes and shorter hospital stay, all of which will help facilitate the increasing demand on healthcare and bed pressure. Its principles and many components are not only transferable to other surgical specialities, but may also allow medical specialities to improve patient care and recovery. ERAS is therefore expected to become the standard of care for the majority of hospital inpatients.

Keywords Enhanced recovery after surgery; ERAS; fast-track surgery

Enhanced recovery after surgery (ERAS) programmes utilize a multimodal and multidisciplinary approach to surgical care. ERAS programmes involve integrated preoperative, intraoperative and postoperative evidence-based practice. The aim of ERAS is to reduce the surgical stress response, to maintain physiological function and metabolic homeostasis and to expedite patients' recovery to their baseline status. The concept of ERAS was first introduced to colorectal surgery in the 1990s by Henrik Kehlet with the aim of reducing postoperative complications and length of hospital stay.¹ Despite initial apprehension and slow uptake, ERAS is now widely practised with studies repeatedly showing its safety and its effect on reducing hospital stay.² Following its success in colorectal surgery, ERAS is currently increasingly adopted in upper gastrointestinal (GI) surgery and pancreatic surgery, as well as in non-GI specialities such as orthopaedics and urology.

Preoperative preparation

Preoperative assessment

Once the shared decision has been made to proceed with major surgery, patients should undergo preoperative assessment to

assess their fitness for surgery. Nowadays this is done at dedicated preoperative assessment clinics that are often nurse-led with the support of consultant anaesthetists for the assessment of high-risk patients. The clinic allows assessment of a patient's general fitness, medical co-morbidities and drug history. Simple investigations such as full blood count and renal function, ECG, chest X-ray, a physical stress or simple 6-minute walk test can be carried out as required. Nowadays for major abdominal surgery, many units prefer evaluation of functional capacity using sophisticated tests such as cardiopulmonary exercise testing (CPET) or myocardial perfusion scanning, which provide a more objective assessment to determine a patient's suitability to proceed to surgery and to enable the planning for postoperative critical care admission when necessary.³ A good preoperative assessment helps facilitate same-day admission and avoids unnecessary cancellations. It also provides an opportunity for the assessment of social circumstances to aid discharge planning and social risk factors such as smoking and alcohol consumption, which are linked to an increased risk of postoperative complications such as wound infection and cardiopulmonary dysfunction.

Preoperative education

In addition to assessment of fitness for surgery, patients in an ERAS programme receive preoperative education with information regarding the surgery, anaesthetic procedures, anticipated postoperative recovery and the journey from admission to discharge. Such preoperative education helps alleviate anxiety and encourages patient participation in their recovery process. For bariatric surgery, preoperative information has been shown to improve patients' compliance and to reduce anxiety and stress postoperatively. In colorectal surgery, preoperative stoma education helps to mentally and physically prepare the patients in their expectation and management of their stoma and has been shown to reduce hospital stay.

Smoking and alcohol cessation

Smoking is associated with an increased risk of postoperative wound infection, pulmonary complications and venous thromboembolism. Cessation for at least 4 weeks leading up to surgery should be advised as this has shown to reduce postoperative complications.⁴

Alcohol misusers are at twofold to threefold increased risk of postoperative pulmonary complications, wound complications and increased length of hospital stay. Abstinence has been shown to improve outcomes and should be recommended for at least 4 weeks.⁵

Preoperative anaemia

Patients presenting for surgery should be screened for anaemia, which is defined as a haemoglobin (Hb) of <130 g/litre in men and <120 g/litre in women. In many cases this will be due to iron deficiency caused by chronic inflammation or ongoing blood loss associated with the underlying condition. The presence of anaemia has been shown to result in poor long-term outcomes and increases the risk of postoperative complications, particularly in those with medical co-morbidities. Correction of anaemia should be carried out preoperatively where possible. Oral iron therapy can be poorly tolerated and ineffective in those with

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chronic inflammatory conditions. Intravenous iron infusion, particularly with new formulations, is better tolerated and can result in an effective rise in Hb concentration in as little as 1 week. Transfusion of blood products may be necessary but has been shown in some studies to be associated with poorer short- and long-term outcomes.

Preoperative nutrition

The practice of prolonged fasting period is no longer recommended. Patients are allowed solids (6 hours) and clear fluids (2 hours) prior to induction of anaesthesia. Preoperative fasting inhibits insulin secretion and promotes the release of catabolic hormones.

The provision of oral carbohydrate drinks up to 2 hours prior to surgery has consequently shown to reduce postoperative insulin resistance, reduce protein breakdown, improve muscle strength and shorten hospital stay.

Unintentional weight loss, especially loss of muscle mass, is associated with an increased risk of cardiovascular complications and mortality, as well as prolonged length of stay following colorectal surgery.⁶ Preoperative supplementary nutrition should therefore be considered for patients who have had unintentional preoperative weight loss or for those who are significantly malnourished. Similar consideration should be given to patients with an upper GI or HPB malignancy where the disease process often causes malnutrition for mechanical or functional reasons. Dietician input is recommended and in severe cases it may be beneficial to consider a period of enteric or even parenteral feeding if time allows.

Preoperative mechanical bowel preparation

Mechanical bowel preparation has no impact in reducing anastomotic leak rates or septic complications. It has the potential to cause greater morbidity due to dehydration and electrolyte disturbances, increases length of stay, and is often poorly tolerated by patients.⁵ Mechanical bowel preparation is therefore no longer recommended in colorectal surgery, apart from in specific conditions such as the need for on-table colonoscopy to identify small lesions or bleeding points. Many surgeons continue to use mechanical bowel preparation prior to rectal surgery where the weight of evidence is not as strong.

Thromboprophylaxis

Surgical patients are at an increased risk of postoperative venous thromboembolism due to hospitalization, anaesthesia, and immobilization during and following surgery. The risks are greater in the older age group, underlying malignancy, prolonged abdominal or pelvic surgery, and in patients with complications such as sepsis, acute kidney injury, or in those who require blood transfusion.⁷

When undergoing major surgery, patients should have both mechanical and chemical thromboprophylaxis. Patients should be fitted with antiembolic stockings or a pneumatic compression device especially in prolonged surgery and pelvic surgery. Prophylactic dosage of unfractionated or low molecular weight heparin should be given to all patients. For patients who are intolerant of heparin, fondaparinux or aspirin could be used as an alternative. For patients who are at higher risk of bleeding, pharmaceutical thromboprophylaxis should only be omitted if the

risk of bleeding outweighs the risk of thromboembolism. In such cases, it may be necessary to consider insertion of a caval filter.

Thromboprophylaxis is traditionally given while patients are admitted to hospital. The length of stay is, however, often shorter with ERAS programmes leading to suggestion that it should be given for 7–10 days in these patients or extended to 28 days postoperatively in patients with underlying cancer, morbid obesity or prolonged abdominopelvic surgery.⁵

Intraoperative strategies

Anaesthesia

The use of rapid short-acting anaesthetic agents (e.g. desflurane), short-acting opioids (e.g. remifentanyl) and muscle relaxants have helped to facilitate more rapid awakening and reduce the need for prolonged period of postoperative recovery and monitoring.

The use of regional anaesthesia (e.g. epidural or spinal opioids) is helpful in the management of postoperative pain and the prevention of postoperative nausea and vomiting (PONV). This may help to reduce patients' stress response and the release of catabolic hormones thereby reducing the incidence of insulin resistance and consequent wound and cardiovascular complications.

Antimicrobial prophylaxis

Antibiotic prophylaxis reduces postoperative wound infection by 20–30% following colorectal surgery. Either systemic or oral antibiotic prophylaxis has a positive effect in reducing postoperative wound infection, although the effect of oral antibiotic prophylaxis is inferior to systemic administration. The antibiotics used should have antimicrobial actions against both aerobic and anaerobic pathogens and should be based on local antibiotic policy. A combination of antibiotics is more effective than single-drug regime and should be given within 1 hour prior to incision and needs to be repeated 3 hours later in prolonged cases or in cases where significant blood loss has occurred. Prolonged antibiotic prophylaxis (i.e. more than 24–48 hours postoperatively) does not provide additional benefit and moreover predisposes to the development of *Clostridium difficile* infection.⁹

A combination of oral and systemic antibiotic prophylaxis may be more effective than either route on its own, with multiple studies showing a decreased risk of wound infection.⁸ These studies were, however, performed in conjunction with mechanical bowel preparation, and therefore further studies are required to establish the benefit of oral antibiotic prophylaxis without mechanical bowel preparation. Studies on patients undergoing gastrectomy and oesophagectomy where mechanical bowel preparation is not given have shown reduced infection rates.⁸

Postoperative nausea and vomiting (PONV)

PONV affects 25% of surgical patients, and is associated with delayed commencement of oral intake, recovery of gut function and a prolonged length of stay. Risk factors for PONV include female sex, non-smokers, those with history of PONV or motion sickness, major abdominal surgery and the use of volatile anaesthetic agents or parenteral opiates.

A multimodal approach combining non-pharmacological and pharmacological techniques to prevent PONV is recommended.

Preventative measures include minimizing the usage of opiates and volatile anaesthetic agents, shortening the duration of pre-operative fasting, preoperative carbohydrate loading and improved hydration.

There are four main pharmacological subtypes of antiemetics: cholinergic, dopaminergic, serotonergic and histaminergic. Two or more antiemetics of different subtypes should be used in combination to improve the antiemetic effect. Dexamethasone has been shown to have a positive effect in the prevention or management of PONV, although it should be omitted in diabetic patients, the elderly and patients with mental health issues due to its risks of hyperglycaemia and psychiatric disturbance.¹⁰

In cases of established PONV, other antiemetic subtypes that have not been used prophylactically should be utilized.⁴

Fluid management

Liberal or excessive administration of fluid has a detrimental effect on cardiorespiratory function and tissue healing, which contributes to an increased risk of complications and prolonged hospital stay. Goal-directed fluid therapy is a strategy in which the administration of intravenous fluids is tailored to cardiac output so as to prevent both dehydration and fluid overload. The most common method of cardiac output monitoring is the oesophageal Doppler, although other methods such as LidCo® or PICCO® which rely on invasive arterial pressure monitoring are available.¹¹ The use of goal-directed fluid therapy is associated with lower rates of postoperative infectious and cardiorespiratory complications, lower incidence of PONV and reduced gut oedema which allows a quicker return of bowel function.

Excessive fluid therapy in the postoperative period should also be avoided. Intravenous fluids should be ceased as soon as oral intake is sufficient. When administration of intravenous fluids is required, however, the use of a balanced crystalloid solution (e.g. Hartmann's solution) should be preferred over a normal saline solution (i.e. 0.9% NaCl).

Moreover, in patients with epidural-induced hypotension, the use of vasopressors is preferred over intravenous fluid therapy.

Thermoregulation

Hypothermia predisposes to coagulopathy, impaired immunity and an increased surgical stress response. Maintaining normothermia is therefore important to reduce complications such as bleeding, wound infection and cardiac events.⁴ Simple measures include the intraoperative use of a forced-air warming blanket, heating mattress and/or warmed intravenous fluids. On the other hand, it is equally important to avoid hyperthermia.

Surgery

Laparoscopic surgery is the preferred approach in patients undergoing bariatric surgery. The cost and technical complexity associated with a laparoscopic approach are compensated by a reduction in postoperative complications and shorter hospital stay.¹² In colonic surgery, minimally invasive surgery is increasingly accepted as the preferred approach. Laparoscopic surgery is associated with a reduced surgical stress response, improved cardiorespiratory function, earlier return of gut function and shorter length of hospital stay without compromising oncological outcomes. The benefits, however, have not been replicated as strongly in pelvic/rectal surgery.⁵ The long-term

outcomes of newer minimally invasive techniques such as robotic surgery or transanal minimally invasive surgery (TAMIS) are still awaited. Similarly, in upper GI surgery minimally invasive gastrectomy and oesophagectomy have shown to be safe with the perceived advantage of less complications in terms of intraoperative blood loss, pulmonary complications and shorter intensive care and hospital admission. The evidence in upper GI cancer surgery is, however, not as strong as operations are often prolonged due to the complexity and concerns regarding the long-term oncological outcomes.^{13,14}

Nasogastric tube insertion

Routine nasogastric intubation has been shown to increase the risks of postoperative pulmonary complications.⁴ Nasogastric intubation moreover does not prevent postoperative ileus. It is therefore recommended to avoid nasogastric intubation or to remove the tube at the end of surgery. Similarly, prophylactic nasogastric decompression does not improve outcome following upper GI and pancreatic surgery even among patients who develop delayed gastric emptying postoperatively.

Peritoneal cavity drainage

Following pancreatic surgery, drains are often routinely used to prevent the development of intra-abdominal collections due to leakage from the pancreatic ducts. Early removal of drains in patients who are at low risk of fistulation (drain fluid amylase <5000 U/litre) on day 3 post-operation is recommended to help reduce risks of pancreatic fistula. In colorectal surgery, the routine use of abdominal drains does not provide an advantage in the detection or management of anastomotic leaks,¹⁴ a finding that is confirmed in other GI subspecialties.¹⁵ Abdominal drains, moreover, have the potential to cause complications such as drain site infection or bleeding, false reassurance due to a blocked or poorly functioning drain, small bowel or omental evisceration, iatrogenic injury or the formation of entero-cutaneous fistula. The use of abdominal drains nevertheless forms an important adjunct in certain circumstances, such as when there is a need to monitor for postoperative bleeding.

Postoperative strategies

Early nutrition and mobilization are key components of the postoperative phase of ERAS.

Nutritional care

Prolonged postoperative fasting is no longer a recommended practice. In colorectal surgery, early feeding has been shown to reduce postoperative infection rates and length of hospital stay, without an increased risk of anastomotic leak. Early feeding together with preoperative carbohydrate loading and regional analgesia have been shown to minimize perioperative insulin resistance.⁶

Early feeding has also been shown to be safe in upper GI and pancreatic surgery, although patients are advised to increase oral intake more cautiously.^{13,14} In patients who are malnourished or affected by delayed gastric emptying, naso-jejunal feeding can be considered. Parenteral nutrition is not recommended unless there is prolonged gut dysfunction, e.g. in cases of prolonged ileus provided that any underlying precipitation factor has been dealt with.

Early mobilization

Early mobilization reduces pulmonary complications and prevents muscle atrophy. Patients should be encouraged to mobilize as soon as possible with exercise plans that start on the first postoperative day, which is promoted by the early removal of urinary catheters and cessation of intravenous fluid administration. Failure to mobilize is a common cause of deviation from the ERAS programme resulting in a prolongation of hospital stay. This is caused by a variety of factors including poor pain control, indwelling urinary catheter or peritoneal drain, continued intravenous fluid administration, poor patient motivation and a lack of staff encouragement.

Postoperative analgesia

Good pain management is a key component to promote early mobilization. A good analgesic regimen should provide adequate pain relief without causing complications such as drowsiness, respiratory deficiency, or nausea and vomiting with a consequent delay in the return of oral intake and gut function.

Opiates should be avoided where possible due to their effect on gut mobility and side effects (e.g. nausea and drowsiness). A multimodal regimen with paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) generally suffices following the immediate postoperative period. Analgesia in the early postoperative period (i.e. the first 24 hours) remains a subject of debate. Thoracic epidural analgesia (TEA) remains commonly used following open surgery because of its analgesic effects and a reduced risk of PONV, leading to earlier return of gut function and reduced insulin resistance.⁴ The benefits of TEA in laparoscopic surgery are, however, less clear as analgesic requirements are lower compared to open surgery. Alternative methods for analgesia in the early postoperative period include spinal analgesia, transversus abdominis plane (TAP) blocks, intravenous lidocaine infusion and local anaesthetic wound catheters. Evidence supporting a significant benefit of one of these methods over the others is currently lacking.

Prevention of postoperative ileus

Postoperative ileus following abdominal surgery is a common cause of prolonged length of stay. Different components of the ERAS programme are directed at reducing the risk of postoperative ileus, including early nutrition, goal-directed fluid therapy to prevent fluid overload and gut oedema, omission of prophylactic nasogastric tube decompression, and laparoscopic surgery.

The use of pharmacological measures such as prokinetic agents (e.g. metoclopramide) and osmotic laxatives (e.g. magnesium hydroxide) has yielded mixed results. Alvimopan (an opioid receptor antagonist) has been shown to facilitate GI recovery with a reduction in postoperative ileus and shorter hospital stay.⁴

The team

The success of any ERAS programme is a direct reflection of the composition and functionality of the ERAS team. Representatives of all those involved in the care of the patient prior to, throughout and following their hospital stay should be involved in the implementation of any ERAS programme. Hence, the team should include specialist nurses, ward nursing staff, dieticians,

Summary of enhanced recovery strategies

Preoperative

- Education
- Avoidance of prolonged fasting
- Avoidance of mechanical bowel preparation
- Nutritional supplementation
- Correction of anaemia
- Carbohydrate loading
- Medical optimization and risk management
- Smoking and alcohol cessation
- Stoma education

Intraoperative

- Thermoregulation
- Prevention of nausea and vomiting
- Minimally invasive surgery
- Goal-directed fluid management
- Short-acting anaesthetic agents
- Avoidance of nasogastric tubes and drains
- Antibiotic prophylaxis

Postoperative

- Multimodal analgesia
- Avoidance of opiates
- Early removal of urinary catheter
- Avoidance of fluid overload
- Early feeding
- Early mobilization
- Daily goals and discharge planning

Box 1

physiotherapists, medical staff and, where possible, representatives of patients and general practitioners. Input from all specialities should result in a well-organized and compliant programme with flexibility to further develop based on audit and feedback from patients and staff (see [Box 1](#)).

Conclusion

ERAS programmes are of benefit to patients throughout their operative journey and postoperative recovery. This translates to a standardized patient care pathway, improved clinical outcomes and shorter hospital stay, all of which facilitate the increasing demand on healthcare and bed pressure. Its principles and many components are transferable to all surgical specialities to improve patient care and recovery and have now become the standard of care for the majority of hospital inpatients.

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Practice points

- Enhanced recovery aims to minimize the patient's surgical stress response, maintain physiological function and expedite the patient's return to baseline status
- Enhanced Recovery After Surgery (ERAS) programmes involve integrated preoperative, intraoperative and postoperative evidence-based practice
- Preoperative factors include anaesthetic assessment, patient education with management of expectations, smoking and alcohol cessation, avoidance of mechanical bowel preparation and use of preoperative carbohydrate loading
- Intraoperative factors include fluid optimization, minimally invasive surgery, postoperative nausea and vomiting prophylaxis, thermoregulation and avoidance of drains and nasogastric tubes
- Postoperative factors include a multimodal approach to analgesia, avoidance of opiates, mobilization, early feeding and discharge planning
- Standardized use of an ERAS pathway has been shown to improve patient outcomes and short hospital stay without an increase in rates of hospital readmission